

REMARKS

In the Office Action, the Examiner rejected claims 1-14 under 35 U.S.C. § 102(b) as being anticipated by United States Patent No. 6,204,179 (McTeer) and further rejected claims 1-14 under 35 U.S.C. § 103(a) as being unpatentable over McTeer in view of United States Patent No. 6,150,252 (Hsu et al.). The independent claims have been amended to further distinguish the claimed invention from that which is disclosed in the cited references. Additionally, a Declaration from one of the inventors is enclosed in support of the present Office Action Response.

Specifically, the independent claims have been amended to specifically claim a permanent interconnect liner layer of aluminum-0.5% copper alloy. The major target of the present invention is to create an additional metal liner between the diffusion barrier (Ta/TaN) and the copper inside the vias and trenches. This liner should be characterized by a good electrical conductivity and at the same time by a good enough resistivity to the electromigration. This liner should survive during the chip lifetime. The present application claims using aluminum-0.5% copper alloy as the material for this liner.

In contrast, United States Patent No. 6,204,179 (McTeer) uses a sacrificial Al liner as a wetting underlayer to assist a gap-fill by copper reflow. McTeer needs this Al to lower the Cu reflow temperature (to prevent diffusion barrier material from the chemical erosion). As mentioned in column 18, lines 15-18, "...the aluminum wetting layer is consumed thereby forming a Cu<sub>n</sub>Al alloy layer wherein n is an integer from about 0.5 to about 4". The Examiner has determined that this means 0.5% copper alloy, however, one having ordinary skill

Serial No.: 10/615,042  
Art Unit: 2815  
Page 5

in the art would interpret McTeer, and specifically column 18, lines 15-18 of McTeer, to mean that the alloy is from interval of atomic compositions: from 2Al - 1Cu to 1Al - 4Cu, which means an alloy with Cu concentration from 33% to 80%, but not 0.5%.

To one having ordinary skill in the art, it is clear why McTeer needs such alloys. The melting point will be reduced almost twice when 40-50% of Al will be added to Cu (compared with the Cu melting point). In the present invention, this Cu concentration is not acceptable because it will dramatically increase a resistivity of the Al liner and will destroy the purpose of its employment.

United States Patent No. 6,150,252 (Hsu et al.) does not disclose or suggest a copper fill. In addition to specifically claiming a permanent interconnect liner layer of aluminum-0.5% copper alloy, the independent claims of the present invention specifically claim a copper fill. In contrast, Hsu et al. discloses filling with aluminum (see col. 9, lines 1-10).

An additional very important point that should be taken into account when comparing the present invention to McTeer and Hsu et al. is the complete difference in copper technology that is employed in the present invention.

Serial No.: 10/615,042  
Art Unit: 2815  
Page 6

A prior-art reference is analogous if

- (1) the art is from the same field of endeavor, regardless of the problem addressed; and
- (2) if not from the same field of endeavor, whether it is still reasonably pertinent to the particular problem to be solved.

E.g., *In re Clay*, 966 F.2d 656, 658-59, 23 U.S.P.Q2d 1058, 1060 (Fed. Cir. 1992); MPEP Section 2141.01(a). But just because the two references at issue in this case relate to interconnects, does not mean they are from the same field of endeavor. For example, in the *Clay* case, the Office argued that the prior art patent and the application at issue were part of a common endeavor: maximizing withdrawal of petroleum stored in petroleum reservoirs. The Court held that the art is not within the same field of endeavor merely because both relate to the petroleum industry. The application at issue was for storage of refined liquid hydrocarbons; the prior art patent was for the extraction of crude petroleum. *In re Clay, supra*, at 659, 23 U.S.P.Q.2d at 1060.

Similarly, in *Wang Laboratories Inc. v. Toshiba Corp.*, 993 F.2d 858, 26 U.S.P.Q.2d 1767 (Fed. Cir. 1993), cited at Section 2141.01(a) of the MPEP, the patents-in-suit were for single in-line memory modules. The prior art at issue was for single in-line memory modules. The Federal Court stated, nonetheless:

*The Allen-Bradley art is not in the same field of endeavor as the claimed subject matter merely because it relates to memories. It involves memory circuits in which modules of varying sizes may be added or replaced; in contrast, the subject patents teach compact modular memories.*

Serial No.: 10/615,042

Art Unit: 2815

Page 7

*Id.* at 864, 26 U.S.P.Q.2d at 1773 (emphasis added). Even though both the application and the prior art reference described SIMMs, they were still different fields of endeavor.

McTeer and Hsu et al. are similarly not in the same field of endeavor as the present invention. The present invention uses a standard dual damascene copper process, where copper is deposited by the electroplating (current standard). Everything that the present invention proposes is the introduction of an additional process step, which is a PVD-based deposition of Al-0.5% Cu liner on the top of the deposited diffusion barrier (TaN), in the standard process flow. McTeer has used the PVD technique for copper deposition, and this is a reason why McTeer needs to introduce a copper reflow step and to deposit a sacrificial Al liner.

Hsu et al. uses a high pressure processing for cavity filling. It is a two-step process: deposition of a thin liner, followed by deposition of a thicker layer to close the mouth of the cavity and high pressure processing to force the fill layer further into the cavity to complete cavity filling. (column 2, lines 55-58). Hsu et al. needs the first liner for wetting purposes only.

Applicant respectfully submits that neither McTeer nor Hsu et al. disclose or suggest providing an aluminum-0.5% copper alloy interconnect liner layer in contact with a copper fill.

In view of the above amendments and remarks, Applicant respectfully submits that the claims are allowable over the prior art of record, and respectfully requests that the application be passed to issuance.

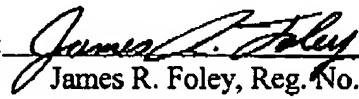
Serial No.: 10/615,042  
Art Unit: 2815  
Page 8

Should the present claims not be deemed adequate to effectively define the patentable subject matter, the Examiner is respectfully urged to call the undersigned attorney of record to discuss the claims in an effort to reach an agreement toward allowance of the present application.

Respectfully submitted,

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Serial No.: 10/615,042

Art Unit: 2815

Page 9